

IN THE CLAIMS

1. (Currently Amended) A method for updating modifying a file system snapshot, comprising:

accessing a first-specified file system snapshot in a plurality of file system snapshots, wherein the first-specified file system snapshot ~~includes data contents comprises at least one empty inode, wherein an empty inode indicates that metadata corresponding to the empty inode is contained in one of a more recent snapshot and a source file system;~~

determining if an inode to be modified in the specified snapshot is an empty inode;

copying, in response to determining the inode to be modified is an empty inode, metadata corresponding to the inode to be modified into the inode to be modified;

copying the data contents of the first file system snapshot, wherein the data contents includes any one of:

~~at least one shadow inode and at least one data block referenced by a disk address in a shadow inode; and~~

~~at least one shadow inode, and~~

writing the metadata into the data contents which have been copied to a next oldest file system snapshot; and

modifying the metadata copied into the inode to be modified.

2. (Currently Amended) The method of claim 1, ~~wherein the copying of the data contents comprises copying the data contents of the first file system snapshot, wherein the metadata contents includes any one of:~~

~~at least one shadow inode, at least one indirect block referenced by a shadow inode and at least one data block referenced by a disk address in an indirect block; and~~

~~at least one shadow inode.~~

3. (Currently Amended) The method of claim 1, further comprising:  
    updating the metadata contents of the first specified file system snapshot in accordance with modifications to at least one source file corresponding to the first specified file system snapshot.
4. (Currently Amended) The method of claim 1, further comprising:  
    accessing a next most recent file system snapshot;  
    copying the a next metadata contents of the next most recent file system snapshot, wherein the next metadata contents includes any one of:  
        at least one shadow inode and at least one data block referenced by a disk address in a shadow inode; and  
        at least one shadow inode, and  
        writing the next metadata contents which have been copied to the first specified file system snapshot.
5. (Currently Amended) The method of claim 4, ~~wherein the copying of the data contents includes copying further comprising writing the next metadata into the next oldest file system snapshot contents of the next most recent file system snapshot, wherein the data contents includes any one of:~~  
    ~~at least one shadow inode, at least one indirect block referenced by a shadow inode and at least one data block referenced by a disk address in an indirect block; and~~  
    ~~at least one shadow inode.~~

6. (Currently Amended) A method for retrieving modifying snapshot data, comprising:

accessing a specified file system snapshot in a plurality of file system snapshots, wherein the specified file system snapshot comprises at least one inode comprising at least one ditto address, wherein the at least one ditto address refers to a data block that has a disk address in an inode associated with one of a more recent snapshot and a source file system in a snapshot dataset a shadow inode corresponding to a source file;

determining if a data block to be modified is referenced by a ditto address in an inode of the specified file system snapshot whether the shadow inode includes a disk address;

copying, in response to determining the data block to be modified is referenced by a ditto address in an inode of the specified file system snapshot, the data block to be modified into the specified snapshot;

copying the data block to be modified into a next oldest file system snapshot; and

modifying the data block copied into the specified snapshot.

wherein if the shadow inode includes a disk address, reading a data block referenced by the disk address;

wherein if the shadow inode does not include a disk address and a next most recent snapshot dataset exists, accessing the next most recent snapshot dataset and repeatedly executing the first accessing step, the determining step and the second accessing step until the reading step is executed; and

wherein if the shadow inode does not include a disk address and a next most recent snapshot dataset does not exist, accessing a file system inode corresponding to the shadow inode and reading a data block referenced by a disk address in the file system inode.

7. (Currently Amended) The method of claim 6, further comprising:  
~~wherein the copying a data block to be modified comprises if the shadow inode includes a disk address, reading an indirect block referenced by the disk address and at least one data block referenced by at least one disk address in the indirect block.~~
  
8. (Currently Amended) The method of claim 6, further comprising:  
~~wherein the copying a data block to be modified comprises if the shadow inode does not include a disk address, accessing one of a next-most recent snapshot dataset and the source file system to read the metadata having the same ancestor as the first snapshot dataset and repeatedly executing the first accessing step, the determining step and the second accessing step until the reading step is executed.~~

9. (Currently Amended) A system for updating modifying a file system snapshot, comprising:

means for accessing a first specified file system snapshot in a plurality of file system snapshots, wherein the first specified file system snapshot comprises at least one empty inode, wherein an empty inode indicates that metadata corresponding to the empty inode is contained in one of a more recent snapshot and a source file system includes data contents;

means for determining if an inode to be modified in the specified snapshot is an empty inode;

means for copying, in response to determining the inode to be modified is an empty inode, metadata corresponding to the inode to be modified into the inode to be modified;

means for copying the data contents of the first file system snapshot, wherein the data contents includes any one of:

at least one shadow inode and at least one data block referenced by a disk address in a shadow inode; and

at least one shadow inode, and

means for writing the metadata into the data contents which have been copied to a next oldest file system snapshot; and

means for modifying the metadata copied into the inode to be modified.

10. (Currently Amended) The system of claim 9, wherein the means for copying of the data contents comprises means for copying the data contents of the first file system snapshot, wherein the metadata contents includes any one of:

at least one shadow inode and at least one data block referenced by a disk address in a shadow inode; and

at least one shadow inode.

11. (Currently Amended) The system of claim 9, further comprising:  
means for updating the metadata contents of the first specified file system snapshot in accordance with modifications to at least one source file corresponding to the first specified file system snapshot.
12. (Currently Amended) The system of claim 9, further comprising:  
means for accessing a next most recent file system snapshot;  
means for copying the a next metadata contents of the next most recent file system snapshot, wherein the next metadata contents includes any one of:  
at least one shadow inode and at least one data block referenced by a disk address in a shadow inode; and  
at least one shadow inode, and  
means for writing the next metadata contents which have been copied to the first specified file system snapshot.
13. (Currently Amended) The system of claim 12, wherein the means for copying of the data contents includes means for copying further comprising writing the next metadata contents into the next oldest file system snapshot of the next most recent file system snapshot, wherein the data contents includes any one of:  
~~at least one shadow inode, at least one indirect block referenced by a shadow inode and at least one data block referenced by a disk address in an indirect block; and~~  
~~at least one shadow inode.~~

14. (Currently Amended) A system for retrieving snapshot data, comprising:

means for accessing a specified file system snapshot in a plurality of file system snapshots, wherein the specified file system snapshot comprises at least one inode comprising at least one ditto address, wherein the at least one ditto address refers to a data block that has a disk address in an inode associated with one of a more recent snapshot and a source file system in a snapshot dataset a shadow inode corresponding to a source file;

means for determining if a data block to be modified is referenced by a ditto address in an inode of the specified file system snapshot whether the shadow inode includes a disk address;

means for copying, in response to determining the data block to be modified is referenced by a ditto address in an inode of the specified file system snapshot, the data block to be modified into the specified snapshot;

means for copying the data block to be modified into a next oldest file system snapshot; and

means for modifying the data block copied into the specified snapshot.

means for reading a data block referenced by the disk address;

means for accessing a next most recent snapshot dataset and repeatedly executing the first means for accessing, the means for determining and the second means for accessing until the means for reading is executed; and

means for accessing a file system inode corresponding to the shadow inode and reading a data block referenced by a disk address in the file system inode.

15. (Original) The system of claim 14, further comprising:

means for reading an indirect block referenced by the disk address and at least one data block referenced by at least one disk address in the indirect block.

16. (Currently Amended) The system of claim 14, further comprising:

means for accessing one of a next most recent snapshot dataset and the source file system to read the metadata having the same ancestor as the snapshot dataset and repeatedly executing the first means for accessing, the means for

~~determining and the means for reading.~~

17. (Currently Amended) A computer readable medium including computer instructions for updating a file system snapshot, the computer instructions comprising instructions for:

accessing a first-specified file system snapshot in a plurality of file system snapshots, wherein the first-specified file system snapshot ~~includes data contents comprises at least one empty inode, wherein an empty inode indicates that metadata corresponding to the empty inode is contained in one of a more recent snapshot and a source file system;~~

determining if an inode to be modified in the specified snapshot is an empty inode;

copying, in response to determining the inode to be modified is an empty inode, metadata corresponding to the inode to be modified into the inode to be modified;

copying the data contents of the first file system snapshot, wherein the data contents includes any one of:

~~at least one shadow inode and at least one data block referenced by a disk address in a shadow inode; and~~

~~at least one shadow inode, and~~

writing the metadata into the data contents which have been copied to a next oldest file system snapshot; and

modifying the metadata copied into the inode to be modified.

18. (Currently Amended) The computer readable medium of claim 17, ~~wherein the copying of the data contents comprises copying the data contents of the first file system snapshot, wherein the metadata contents includes any one of:~~

~~at least one shadow inode and at least one data block referenced by a disk address in a shadow inode; and~~

~~at least one shadow inode.~~

19. (Currently Amended) The computer readable medium of claim 17, further comprising instructions for:

updating the metadata contents of the first specified file system snapshot in accordance with modifications to at least one source file corresponding to the first specified file system snapshot.

20. (Currently Amended) The computer readable medium of claim 17, further comprising instructions for:

accessing a next most recent file system snapshot;

copying the a next metadata contents of the next most recent file system snapshot, wherein the next metadata contents includes any one of:

at least one shadow inode and at least one data block referenced by a disk address in a shadow inode; and

at least one shadow inode, and

writing the data contents which have been copied to the first specified file system snapshot.

21. (Currently Amended) The computer readable medium of claim 20, wherein the copying of the data contents includes copying further comprising writing the next metadata into the next oldest file system snapshot contents of the next most recent file system snapshot, wherein the data contents includes any one of:

at least one shadow inode, at least one indirect block referenced by a shadow inode and at least one data block referenced by a disk address in an indirect block; and

at least one shadow inode.

22. (Currently Amended) A computer readable medium including computer instructions for retrieving snapshot data, the computer instructions comprising instructions for:

accessing a specified file system snapshot in a plurality of file system snapshots, wherein the specified file system snapshot comprises at least one inode comprising at least one ditto address, wherein the at least one ditto address refers to a data block that has a disk address in an inode associated with one of a more recent snapshot and a source file system in a snapshot dataset a shadow inode corresponding to a source file;

determining if a data block to be modified is referenced by a ditto address in an inode of the specified file system snapshot whether the shadow inode includes a disk address;

copying, in response to determining the data block to be modified is referenced by a ditto address in an inode of the specified file system snapshot, the data block to be modified into the specified snapshot;

copying the data block to be modified into a next oldest file system snapshot; and

modifying the data block copied into the specified snapshot.

wherein if the shadow inode includes a disk address, reading a data block referenced by the disk address;

wherein if the shadow inode does not include a disk address and a next most recent snapshot dataset exists, accessing the next most recent snapshot dataset and repeatedly executing the first accessing step, the determining step and the second accessing step until the reading step is executed; and

wherein if the shadow inode does not include a disk address and a next most recent snapshot dataset does not exist, accessing a file system inode corresponding to the shadow inode and reading a data block referenced by a disk address in the file system inode.

23. (Currently Amended) The computer readable medium of claim 22, further comprising instructions for:

wherein the copying a data block to be modified comprises if the shadow inode includes a disk address, reading an indirect block referenced by the disk address and at least one data block referenced by at least one disk address in the indirect block.

24. (Currently Amended) The computer readable medium of claim 22, further comprising instructions for:

wherein copying a data block to be modified comprises if the shadow inode does not include a disk address, accessing one of a next most recent snapshot dataset and the source file system to read the metadata having the same ancestor as the snapshot dataset and repeatedly executing the first instructions for accessing, the instructions for determining and the second instructions for accessing until the instructions for reading are executed.

25. (Currently Amended) A system for updating a file system snapshot, comprising:

a first file system snapshot in a plurality of file system snapshots, wherein the first file system snapshot includes data contents;

data contents of the first file system snapshot, wherein the data contents includes any one of: comprises at least one of an empty inode and an inode comprising at least one ditto address,

wherein an empty inode indicates that metadata corresponding to the empty inode is contained in one of a more recent snapshot, and a source file system, and

wherein a ditto address refers to a data block that has a disk address in an inode associated with one of the more recent snapshot, and a source file system;

at least one shadow inode and at least one data block referenced by a disk address in a shadow inode; and

at least one shadow inode; and

means for writing the data contents to a next oldest file system snapshot.

26. (Original) The system of claim 25, wherein the data contents includes any one of:  
at least one shadow inode, at least one indirect block referenced by a shadow  
inode and at least one data block referenced by a disk address in an indirect block; and  
at least one shadow inode.
27. (Original) The system of claim 25, further comprising:  
a next most recent file system snapshot;  
data contents of the next most recent file system snapshot, wherein the data  
contents includes any one of:  
at least one shadow inode and at least one data block referenced by a  
disk address in a shadow inode; and  
at least one shadow inode, and  
means for writing the data contents to the first file system snapshot.
28. (Currently Amended) A system for retrieving snapshot data, comprising:  
a shadow inode in a first snapshot dataset corresponding to a source file, the  
shadow inode comprising at least one of an empty inode and an inode comprising at  
least one implied reference,  
wherein an empty inode indicates that an metadata corresponding to the  
empty inode is contained in one of a more recent snapshot, and a source file  
system, and  
wherein an implied reference refers to a data block that has a disk  
address in an inode associated with one of the more recent snapshot, and a  
source file system; and  
~~a disk address included in the shadow inode;~~  
~~a data block referenced by the disk address;~~  
a next most recent snapshot dataset.

29. (Original) The system of claim 28, further comprising:  
an indirect block referenced by the disk address; and  
at least one data block referenced by at least one disk address in the indirect block.
30. (Currently Amended) The system of claim 28, further comprising:  
a next most recent snapshot dataset having the same a different ancestor as the first snapshot dataset.